An interdisciplinary approach to the understanding of past settlement and farming: two cases from SE Norway

Abstract

An interdisciplinary approach involving analysis of plant macrofossils, pollen and soil micro morphology in combination with large-scale stripping of top soil, was applied in order to get a comprehensive understanding of pre-historic settlement, farming economy and land-use in Østfold, SE Norway. Investigations of 25 sites lead to two distinctive results: 1) A time-space perspective on usages of plants, and 2) Identification of agrarian activities in a relict field. Studies of these topics have hitherto been limited for this region. The results add fresh and essential knowledge to pre-historic times in Østfold and make a significant contribution to the understanding to these topics in neighbouring regions.

Keywords :

- Palaeobotany;
- Soil micro morphology;
- Settlement and farming;
- SE Norway

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1. Introduction

The data basis for this paper are results from investigations conducted by *The E6-Project* in the county of Østfold, SE Norway, and hosted at the Museum of Cultural History, University of Oslo in the years 2003–2007 (Bårdseth, 2007a, Bårdseth, 2007b, Bårdseth, 2007c and Bårdseth, 2008). The background for the investigations was a decision by The Norwegian Public Roads Administration to broaden the existing highway – E6–between Oslo, Norway, and the border towards Sweden, from two to four lanes. Along a distance of approximately 40 km a total of 36 sites next to the existing highway were in conflict. The data presented in this paper originate from 25 of the sites investigated, [1] representing settlements and farming activities from the periods between the Late Neolithic to the Viking Age (c. 2200 BC–1000 AD) (Fig. 1, Table 1).

The county of Østfold is situated in the southernmost part of Eastern Norway, with borders to the Oslo fjord and the Skagerrak Sea to the west and southwest and the country of Sweden to the east and south (cf. Fig. 1). A huge end-moraine deposited during Younger Dryas 12000–11000 years ago, is running in an NW–SE direction through the region (Andersen and Borns, 1994 and Sørensen, 1999). The moraine is still damming up some great lakes, which together with several rivers, forest and marshland dominate the landscape at the proximal side of the moraine. The landscape distal to the moraine holds rich arable land, and is towards Skagerrak fringed by islands and skerries with meagre vegetation. The E6-highway is located along the moraine.

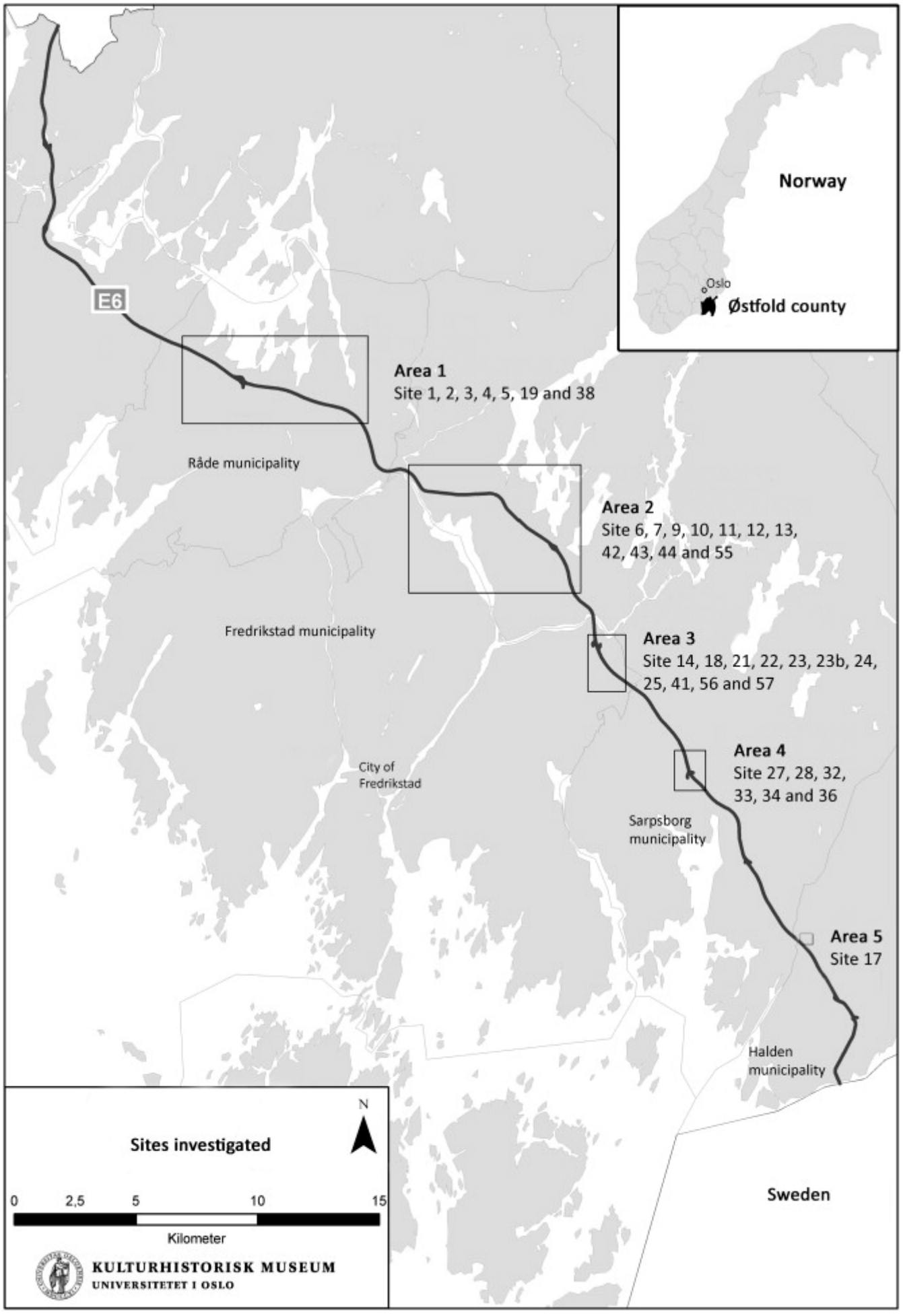

Fig. 1. Sites investigated, county of Østfold, SE Norway. The location of the great end-moraine corresponds to the E6-highway.

Table 1
Overview of sites investigated, their dates and number of samples analysed.

Area	Site no.	Site category	Date	Plant macrofossils	Pollen	Soil micro morphology	AMS-datings on cereals	Conventional datings on charcoal	Area investigated m2
1	1	Farm settlements	Bronze Age	53			12		2000
1	2	Farm settlements	Late Bronze Age and pre-Roman Iron Age	20			1	2	2760
1	3 and 19	Farm settlements and relict fields	Late Bronze Age and pre-Roman Iron Age	129			20	15	5000
1	5	Farm settlements	Roman Iron Age	132			15	12	9700
1	38	Grave cairn	Late Bronze Age or pre-Roman Iron Age	5					
2	6	Relict fields	Pre-Roman Iron Age and Roman Iron Age	20	9	6	1	2	1750
2	9	Farm settlements and relict fields	Late Neolithic, Late Bronz Age, Migration Period, Recent	12			2	2	1100
2	10	Farm settlements and relict fields	Late Neolithic, Late Bronze Age, pre-Roman Iron Age and Roman Age	10	10	4	3	1	1500
2	11	Farm settlements	Late Iron Age	37	1			3	550
2	13	Relict fields	Pre-Roman Iron Age, Iron Age and Migration Period	24	8	3	2	2	1969
2	43	Hollow path	Not dated		7				
2	44	Cemetary, farm settlements	Iron Age	2	13				3000
3	18	Uncertain	Not dated	1					25
3	21 and 56	Farm settlements	Late Bronze Age and pre-Roman Iron Age	16			1	4	2232
3	23 and 23b	Farm settlements	Late Neolithic to the Late Iron Age	58			6	3	3750
3	24	Farm settlements	Iron Age	2					2145
3	57	Activity traces	Late Neolitihc	1					25
4	27	Farm Settlements	Bronze Age and Early Iron Age	37		2	2	10	1600
4	28	Farm Settlements	Pre-Roman Iron Age	13			3	4	1100
4	32	Farm Settlements	Early Iron Age	35			2	2	1948
4	33	Farm settlements	Early Iron Age	52		3	6	7	4000
4	36	Farm Settlements	Roman Age	13			3		900
			SUM	672	48	18	79	69	47054

In order to gain an understanding of pre-historic settlement, farming economy and land-use in Østfold, the project undertook an interdisciplinary approach, involving the combination of large-scale archaeological excavation and palaeoecological surveys including analysis of anthropogenic sediments. Corresponding approaches to the investigation of past societies and environments are at present an established field of research within modern field archaeology (for a Scandinavian perspective sees e.g. Bakkevig et al., 2002, Robinson, 2000, Viklund, 2002 and Welinder et al., 1998). In Østfold however, interdisciplinary investigations have hitherto been limited. Analysis of pollen since 1950 has been performed at several sites, but rarely in connection to archaeological excavations (Danielsen, 1969, Griffin, 1988 and Larssen, 1950, see also summary in Sandvik, 2008: 71–72). These former studies gave an overview of the establishment and changes in vegetation and climate, and the consequences for the landscape of a regressive sea shore displacement in the region during post-Weichsel (Andersen and Borns, 1994 and Sørensen, 1999). Previous analysis of plant macrofossils and pollen from archaeological contexts were restricted to a handful locations, all excavated within the last decade (Høeg, 2002 and Soltvedt, 1999, see summary in Sandvik, 2008:72). Soil micro morphological analysis was not yet conducted in connection to archaeological surveys.

The analysis carried out by the *E6-project* is thus the first broad interdisciplinary approach in connection to archaeological surveys in this part of Norway. The studies lead to two distinctive results, which will be explored in this paper: 1) A time-space perspective on the usages of plants, and 2) Identification of agrarian activities in a relict field.

2. Materials and methods

Except for a grave cairn (site 38) and a hollow path (site 44) the presented sites were by the time of the investigations located in arable land in one of four areas spread along the present E6 (cf. Fig. 1, Table 1). Mechanical stripping of topsoil was the main field survey method. This method had already been successfully utilized in other parts of Norway in investigations of pre-historic settlements and farming activities (Høgestøl, 2005 and Løken et al., 1995).

Analysis of plant macrofossils, pollen and soil micro morphology for this project are conducted by the Museum of Archaeology, University of Stavanger, Norway (Sageidet, 2007a, Sageidet, 2007b, Sandvik, 2007a, Sandvik, 2007b, Sandvik, 2007c, Sandvik, 2008 and Solem, 2007) (cf. Table 1). ^{14}C-datings are conducted by The Norwegian National Laboratory for ^{14}C-datings at the Norwegian University of Science and Technology (NTNU), Trondheim, Norway.

2.1. Analysis of plant macrofossils

The majority of analyses are of macrofossils found by processing of sediment samples collected from contexts such as postholes, fireplaces/hearths and wall-pits from remains of pre-historic settlements in areas 1–4 (Fig. 1) while a minor part are from fields and clearance cairns in area 2. The sample volume before floatation were 0, 5–4 L. All samples were floated in fresh water in a specially developed equipment: The AMS-machine – *Advanced Macrofossil Separator* (Bakkevig, 1998 and Bakkevig et al., 2002) and dried. The plant macrofossils were then sorted into six groups; 1. Imported cultivated plants, 2. Locally cultivated plants, 3. Wild food plants, 4. Annual weeds, 5. Other plants and 6. Cryptogams (Sandvik, 2007a:12–13). Plant macrofossils from 672 samples, collected from 24 sites are analyzed (cf. Table 1 and Table 2).

Table 2
Plant groups and relative quantities of plant macrofossils from the sites investigated. PG: Plant group, +: present; ++: common; B: botanical material; Z: zoological material; M: minerogenic material. Analysis: Paula Utigard Sandvik.

	Area	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4
	Municipality	Råde	Råde	Råde	Råde	Råde	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg
	Site number	1	2	5	3, 19	38	6	9	10	11	13	44	18	21	23	23b	24	56	57	27	28	32	33	36
PG	Plant species, genus, family																							
1	Grape *Vitis vinifera*						+																	
2	Oat *Avena*	+		+	+																		+	+
2	Cerealia, unspecified	++	+	++	++		+	+	+	+	+		+	+	+	+				+	+		++	++
2	Cerealia: unspecified internodium													+	+									
2	Cerealia: fragment	++	+	++	++		+	+	+	+	+			+	+			+	+	+	++	+	+	++
2	Barley *Hordeum vulgare*			+	+			+															++	+
2	Barley *Hordeum*	+	+	+	+																			
2	Barkey, hulled *Hordeum vulgare* var. *vulgare*				+			+															++	+
2	Barley, naked *Hordeum vulgare* var. *nudum*			+																			+	
2	Wheat *Triticum*	+	+		+																			
2	Flax *Linum usitatissimum*			+	+																		+	
2	Millet *Panicum miliaceum*			+	+																		+	
3	Bearberry *Arctostaphylos uva-ursi*				+																			
3	Hazel *Corylus avellana,* fragment of nut shell			+	+				+	+					+	+				+		+	+	
3	Hazel *Corylus avellana,* charcoal				+																			
3	Crowberry *Empetrum nigrum*			+	+			+																
3	Strawberry *Fragaria vesca*			+																				
3	*cf.* Bramble *Rubus cf. fructicosus*			+																				
3	Raspberry *Rubus idaeus*	+	+	+	+		+																+	+
3	*Rubus,* unspecified			+	+																			
3	*Vaccinium,* unspecified				+																			
3	Wetchling/wetch *Lathyrus/Vicia*		+	+	+										+								+	+
4	Trifid bur Marigold *Bidens tripartita*									+														
4	Fat hen *Chenopodium album*	+	+	++	+					+	+			+	+						+	+	++	+
4	Sun of wart spurge *Euphorbia helioscopia*			+							+											+		
4	Bindweed *Fallopia convolvulus*									+														
4	Pale persicaria *Persicaria lapathifolia*			+	+					+					+								+	
4	Redleg *Persicaria maculosa*			+	+					+													+	
4	Ribwort plantain *Plantago lanceolata*			+	+					+					+									
4	Rattlebox *Rhinanthus*			+						+														
4	Corn spurrey *Spergula arvensis*	+	+	++	++					+	+				+					+			++	
4	Chickweed *Stellaria media*	+	+	++	+					+	+				+	+		+		+		+	++	
4	Field pennycress *Thlaspi arvense*			+	+																			
4	Burning nettle *Urtica urens*									+														
5	Alder *Alnus, charcoal*																							
5	Cow parsley *Anthriscus sylvatica*																						+	
5	Silverweed *Argentina anserina*									+														
5	Birch *Betula,* charcoal		+	+			+	+		+	+		+	+	+			+		+	+	+	+	
5	Sedge *Carex,* distigmaticae	+		+	+																			
5	Sedge *Carex,* tristigmaticae	+		+	+					+													+	+
5	Goosfoot *Chenopodium /Atriplex*	+		+	+		+																	
5	Ash *Fraxinus excelsior, charcoal*			+																				
5	Hemp nettle *Galeopsis*			+	+																			
5	Bedstraw *Galium*		++	+	++		+		+	+	+				+	+				+		+	+	
5	Rush *Juncus*			+						+													+	+
5	Juniper *Juniperus communis*							+																
5	Knotweed *Persicaria*			+																				
5	Pine *Pinus sylvestris,* charcoal			+	+					+														
5	Grass Poaceae			+	+																		+	
5	Knotgrass *Polygonum*	+	+	+	+					+	+													
5	Cinquefoil *Potentilla*			+																			+	
5	Bird cherry *Prunus padus,* charcoal			+							+													

Table 2 *(continued)*

	Area	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4
	Municipality	Råde	Råde	Råde	Råde	Råde	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Fredrikstad	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg	Sarpsborg
	Site number	1	2	5	3, 19	38	6	9	10	11	13	44	18	21	23	23b	24	56	57	27	28	32	33	36
5	Oak *Quercus,* charcoal			+																				
5	Buttercup *Ranunculus*	+		+	+		+																+	
5	Dock *Rumex*			+	+																			
5	Sorrel *Rumex acetosa*									+														
5	Sheeps sorrel *Rumex acetosella*			+	+		+																	
5	Willow *Salix, charcoal*		+	+	+										+					+	+		+	
5	Cockle *Silene dioica/latifolia*			+	+																			
5	Nightshade Solanacae																						+	
5	Rowan *Sorbus, charcoal*										+													
5	Penny cress *Thlaspi arvense*						+																	
5	Clover *Trifolium*			+			+	+																+
5	Nettle *Urtica dioica*									+														
5	Violet *Viola*									+														
5	Varia	+	+	+	++		+	+	+	+	+			+	+	++		+	+	++	++	+	++	+
6	*Cenococcum geophilum*	++	++	++	++	+		++	++	+	++				+	+	+	+	+	+	+		+	+
6	Spikemoss *Selaginella selaginoides*			+																				
B	Needle	+		+	+	+		+	+									+			+			
B	Leaf							+							+							+	+	
B	Bark		+	+	+			+		+	+				+							+		
B	Botanical remains, unspecified	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+		+	+		+	+	
B	Bread/porridge			+	++															+			+	
B	Diaspora, charred	++	+	++	++		+	+	+	+	+		+	+	+	++		+	+	+	+	+	+	++
B	Diaspora, uncharred	+	+	+	+	+	+	+	+	+	+			+	+	++		+		+	+	+	+	+
B	Hether/twig										+													
B	Roots			+					+					+	+		+	+	+			+		
B	Fungi	++	++	++	++	+	+	++	++	+	++				+	++	++	+	+	+	+		++	+
B	Straw, uncharred			+																				
B	Charcoal	++	++	++	++	+	+	++	++	+	++	+	++	++	+	++	++	++	+	++	++	+	++	++
B	Wood				+	+				+														
Z	Bone, charred	+		+	+		+			+					+			+					+	+
Z	Bone, uncharred			+											+								+	
Z	Ephippium									+														
Z	Fly puparia										+													
Z	Insect		+	+	+	+	+	+	+	+	+		+	+	+	+				+	+	+	+	+
Z	Shell		+			+																	+	
Z	Turbellaria		+	+	+	+	+		+	+					+					+	+		+	
Z	Zoological remains, uspesified																						+	
Z	Fiber, unspecified														+									
M	Stone		+		+																			
M	Gravel		+	+	+									+	+	+				+	+	++	+	
M	Sand	++	++	++	++	+	+	++	+	+	+	+	++	++	+	++	++	++		++	++	++	++	++
M	Silt			+																				
M	Clay			+	+			+							+	+					+	+	+	+
M	Mixed minerogenlc materiale			+	+		+		+	+	+				+				+		+	+	+	+

2.2. Analysis of pollens

The samples were collected in vertical series from cross-sections through pre-historic fields and clearance cairns from a sunken road at sites in area 2 (Fig. 1, Table 1). The sunken road was surrounded by several past fields, and the analysis aimed to reflect the vegetation in this pre-historic environment around the road. The sample-volume measured from 1 to 3 cm^3. The samples were prepared according to the standard for absolute pollen analysis (cf. Fægri et al., 1989, Robertsson, 1989 and Stockmarr, 1972). Pollen from 48 samples collected from six sites is analyzed. In this paper results from site 13 in area 2 is presented (cf. Fig. 5, Table 1).

2.3. Analysis of soil micro morphology

The analysis of soil micro morphology are conducted on 18 samples, collected from the sites 6, 10 and 13 in area 2 and 27 and 33 in area 4 (cf. Table 1). Of these 13 samples were collected from vertical cross-sections through past fields at the sites in area 2, while five samples were from contexts in and around pre-historic houses at the sites in area 4 (Fig. 1, Table 1). The samples were collected in *Kubiena*-boxes, 4 × 6 × 10 cm (Kubiena, 1938). Thin sections of the sediment samples were prepared for analysis at the University of Ghent, Belgium. In this paper analysis from site 13 in area 2 are presented (Fig. 5, Fig. 10, Fig. 11 and Fig. 12).

2.4. Other methodologies and approaches

In addition to the methodologies mentioned above, the identification of charred bones of humans and animals was carried out (Holck, 2004, Holck, 2005, Hufthammer, 2004 and Hufthammer, 2006). At a smaller scale, the identification of insects (Hellqvist, 2006a and Hellqvist, 2006b) and the mapping of phosphate were conducted (Lienemann, 2004). Radiocarbon dates of 159 samples are determined, of which 79 are of carbonized cereals. The remaining dated samples are foremost conducted on charcoal and some on bones. A GIS system was established as a means to record the geographical distribution of archaeological and environmental data (Bårdseth, 2008: 5).

3. Results and discussions

3.1. Case 1. A time-space perspective on usages of plants

The high number of analyzed macrofossil samples (672 samples); together with 79 radiocarbon dates conducted on carbonized cereal grains make the data suitable for evaluation on usages of plants in a time-space perspective. The majority of the sites with identified plant macrofossils were settlement sites (19 out of 24 sites), represented by house-remains. These contexts gave plentiful as well as various selections of species of macrofossils. Table 2 gives an overview of the presence of plant macrofossils and whether they are just present or common. The grouping follows Sandvik (2007a).

3.1.1. Cultivated plants

Among the cultivated plants that occurred most frequently are barley (*Hordeum*) and oat (*Avena*), while wheat (*Triticum*), flax (*Linum usitatissimum*) and millet (*Panicum miliaceum*) are scarce. Cereals were cultivated for human consumption, to make bread, porridge and probably also to brew beer or other alcoholic drinks. Flax could have been cultivated because of its high content of fibre to be used in the production of textiles. Flax-seeds (Fig. 2) which contain fat could have been a part of the human diet either without further preparation or after being processed to oil for specific purposes including consumption. Seeds of millet (Fig. 3) are nutritious and were most probably cultivated for consumption.

Fig. 2. Seed of flax *Linum usitatissimum L*., from site 5, area 2. Photo by Paula U. Sandvik.

Fig. 3. Seed of millet *Panicum miliaceum L.* from site 5, area 2. Photo by Paula U. Sandvik.

Altogether 79 carbonized grains are dated by AMS ^{14}C-dating technology (Table 3). These dates create a time frame for the growth of cereals, from the Late Neolithic to the Migration Period (c. 2200 BC–600 AD (Sandvik, 2008: 69). Of the ^{14}C-datings 36 are conducted on barley and it appears that this plant species was the first one to be introduced in cultivation in Østfold, in the Late Neolithic (c. 2200 BC) and later grown in all the pre-historic periods until the end of the Migration Period (c. 600 AD). Three samples of hulled barley (*Hordeum vulgare* var. *vulgare*) however, are dated to the Pre-Roman Iron Age and the Roman Age. Dates on grains of wheat and oat are few. Two samples of wheat grains are dated to the Late Bronze Age, while a single grain of oat is dated to the Pre-Roman Iron Age. Altogether 37 AMS dates are conducted on none-identified grains. The time frame for 36 of these corresponds to those of barley, c. 2000 BC–600 AD. Another none-identified carbonized grain is dated to the transition between Viking Age and Early Middle Ages.

Table 3
AMS-dates of cereals.

Area	Site no.	Sample ID	Material	^{14}C age	(yr BP ± δ)	Calibrated age
1	1	TUa 4468	Wheat	2765	95	BC 1005–815
1	1	TUa 4620	Grain	2730	40	BC 905–835
1	1	TUa 4622	Grain	2505	50	BC 780–515
1	1	TUa 4621	Barley	2505	35	BC 775–535
1	1	TUa 4616	Grain	2900	40	BC 1135–1010
1	1	TUa 4617	Barley	2830	35	BC 1020–925
1	1	TUa 4619	Barley	3165	40	BC 1460–1405
1	1	TUa 4618	Barley	3085	40	BC 1405–1295
1	1	TUa 4624	Grain	2475	40	BC 760–450
1	1	TUa 4623	Grain	2570	45	BC 805–765
1	1	TUa 4614	Grain	3340	50	BC 1680–1540
1	1	TUa 4615	Grain	3370	70	BC 1730–1545
1	2	TUa 4469	Barley	2380	50	BC 480–395
1	3	TUa 4470	Barley	2080	40	BC 155–35
1	3	TUa 4471	Barley	2165	40	BC 340–160
1	3	TUa 5610	Grain	2440	45	BC 760–405
1	3	TUa 5611	Wheat	2415	40	BC 750–400
2	19	TUa 4472	Barley	2125	40	BC 190–65
2	19	TUa 4473	Grain	2320	40	BC 400–375
2	19	TUa 4474	Grain	2185	40	BC 355–175
2	19	TUa 4475	Hulled barley	2370	40	BC 410–395
2	19	TUa 4476	Oat	2350	40	BC 405–390
2	19	TUa 4477	Barley	2360	40	BC 405–390
2	19	TUa 4628	Grain	2520	55	BC 790–530
2	19	TUa 4631	Grain	2495	35	BC 770–520
2	19	TUa 4632	Grain	2265	45	BC 390–235
2	19	TUa 4633	Barley	3680	50	BC 2140–1970
2	19	TUa 4634	Barley	2500	45	BC 770–520
2	19	TUa 4640	Grain	2465	50	BC 760–435
2	19	TUa 4641	Barley	2390	45	BC 480–400
2	19	TUa 5231	Barley	2300	35	BC 395–370
2	19	TUa 5233	Barley	2610	40	BC 805–790
2	19	TUa 5236	Barley	2900	30	BC 1120–1015
2	5	TUa 4997	Grain	2275	40	BC 390–260
2	5	TUa 4994	Barley	2465	50	BC 755–435
2	5	TUa 4992	Barley	2430	30	BC 535–420
2	5	TUa 5692	Barley	1950	35	AD 30–95
2	5	TUa 5692	Barley	1900	45	AD 65–215
2	5	TUa 4995	Grain	2070	40	BC 120–20
2	5	TUa 5698	Barley	1885	60	AD 60–230
2	5	TUa 5693	Barley	1785	45	AD 180–335
2	5	TUa 5694	Barley	2160	45	BC 350–115
2	5	TUa 5695	Barley	1815	50	AD 130–320
2	5	TUa 5696	Barley	2160	45	BC 350–115
2	5	TUa 5697	Barley	2145	45	BC 345–60
2	5	TUa 5699	Barley	2145	45	BC 345–61
2	5	TUa 5700	Grain	1900	55	AD 30–220
3	21	TUa 4996	Grain	2575	40	BC 750–400
3	23	TUa 4998	Grain	2155	40	BC 210–120
3	23	TUa 4999	Grain	3605	55	BC 2010–1890
3	23	TUa 5623	Barley	1685	35	AD 265–420
3	23	TUa 5622	Barley	1790	35	AD 180–325
3	23	TUa 5712	Barley	2290	45	BC 395–230
4	32	TUa 5001	Grain	1860	35	AD 115–215
4	32	TUa 5000	Grain	1540	35	AD 505–585
2	6	TUa 5617	Grain	2210	40	BC 355–170
2	9	TUa 5618	Barley	3635	80	BC 2130–1830
2	9	TUa 5660	Grain	1735	40	AD 225–385
2	9	TUa 5661	Unidentified seeds	900	40	AD 1040–1210
2	10	TUa 5619	Barley	1725	40	AD 255–405
2	10	TUa 5662	Grain	2675	40	BC 830–795
2	10	TUa 5663	Grain	3610	40	BC 2010–1835
2	13	TUa 5620	Grain	1785	45	AD 180–355
2	13	TUa 5666	Grain	1610	35	AD 415–535
4	27	TUa 5672	Grain	2170	40	BC 350–125
4	27	TUa 5844	Grain	2860	40	BC 1075–935
4	27	TUa 5845	Grain	2875	40	BC 1185–940
4	28	TUa 5624	Grain	1900	35	AD 70–135
4	28	TUa 5674	Grain	2125	40	BC 200–50
4	28	TUa 5675	Grain	2015	40	BC 45-AD55
4	33	TUa 5626	Barley	1565	35	AD 430–545
4	33	TUa 5682	Barley	1540	35	AD 430–595
4	33	TUa 5626	Barley	1595	40	AD 420–540

Table 3 (*continued*)

Area	Site no.	Sample ID	Material	^{14}C age (yr BP ± δ)		Calibrated age
4	33	TUa 5681	Barley	1530	40	AD 435–600
4	33	TUa 5679	Grain	2210	40	BC 355–170
4	33	TUa 5686	Barley	1585	45	AD 420–540
4	36	TUa 5627	Hulled barley	1825	35	AD 130–315
4	36	TUa 5628	Hulled barley	1855	40	AD 90–240
4	36	TUa 5687	Grain	1715	45	AD 260–410

Seeds of millet and flax were not present in enough quantity to contribute satisfactorily samples for ^{14}C-dating. Both seeds of flax and millet were found in samples together with grains dated to the Early Iron Age. It is presumed that species occurring in the same sample to be of the same age.

3.1.2. Wild food plants, weeds and other plants

Wild food plants are well represented by hazelnuts (*Corylus avellana*) and raspberries (*Rubus idaeus)*, while wild peas (*Lathyrus/Vicia*) and a range of berries such as blackberries (*Rubus* cf. *fructicosus*), crowberries (*Empetrum nigrum*) and bearberries (*Arctostaphylos uva-ursi*) are scarce. Remains of wild food plants occurred more or less on the same sites and in the same contexts as the cultivated plants (cf. Table 2). Hazelnuts and berries are nutritious and thereby important food-sources and are both tasty and easy to collect. Species like bearberries might also have been collected due to medical purposes (Høeg, 1976). No seeds of wild food plants or weeds were dated. As these species occur in combination with dated grains, we presumed that they are of the same age as the grain. This implies that both cultivated plants and wild growing plants were part of the human diet from the Late Neolithic to the Viking Age.

Among the most common species of annual weeds are fat hen (*Chenopodium album*), sun-spurge (*Euphorbia helioscopia*), redshank (*Persicaria maculosa*) and pale persicaria (*Persicaria lapathifolia*). Annual weeds occurring together with cultivated plants give indications of both the flora in and around arable land. Their presence together with grains and other cultivated plants depend also on whether the strategy for the harvesting of cultivated plants involved cutting of the straw/stem by the basis of the plant or by just collecting the upper part where the seeds are found.

Other plant species and genus growing in environments influenced by humans are cow parsley (*Anthriscus sylvestris*), clover (*Trifolium*), and butter cup (*Ranunculus*), bedstraw (*Galium*), and cinquefoil (*Potentilla*). The most common cryptogam is the fungus *Cenococcum geophilum* which is living in many types of soil and seems to be common in anthropogenic sediments. On the other hand spike moss (*Selaginella selaginoides*) which today is uncommon in the vegetation in anthropogenic environments, has for some reason been brought into the past settlement in Østfold.

Finally, imported cultivated plants, represented by a single grape-stone (*Vitis vinifera*) occurred in the upper part of the soil in arable land at site 6 (Fig. 1, area 2). The grape stone was not carbonized and is thus not regarded as a relict seed (Sandvik, 2008: 61).

3.1.3. Preliminary conclusions

The analysis of plant macrofossils demonstrated that cultivated plants, wild food plants and annual weeds occurred in contexts and environments representing past settlements and habitation areas (Fig. 4). The cultivation of plants is seen through finds of grains of both hulled barley (*H. vulgare* var *vulgare*) and naked barley (*H. vulgare* var *nudum*), wheat (*Triticum*), oat (*Avena*), flax (*L. usitatissimum*) and millet (*P. miliaceum*) (Table 2).

Fig. 4. Imprints of a three-aisled house from the Migration Period, site 33, area 4. Roof-supporting postholes are marked with white rods. Photo by Museum of Cultural History.

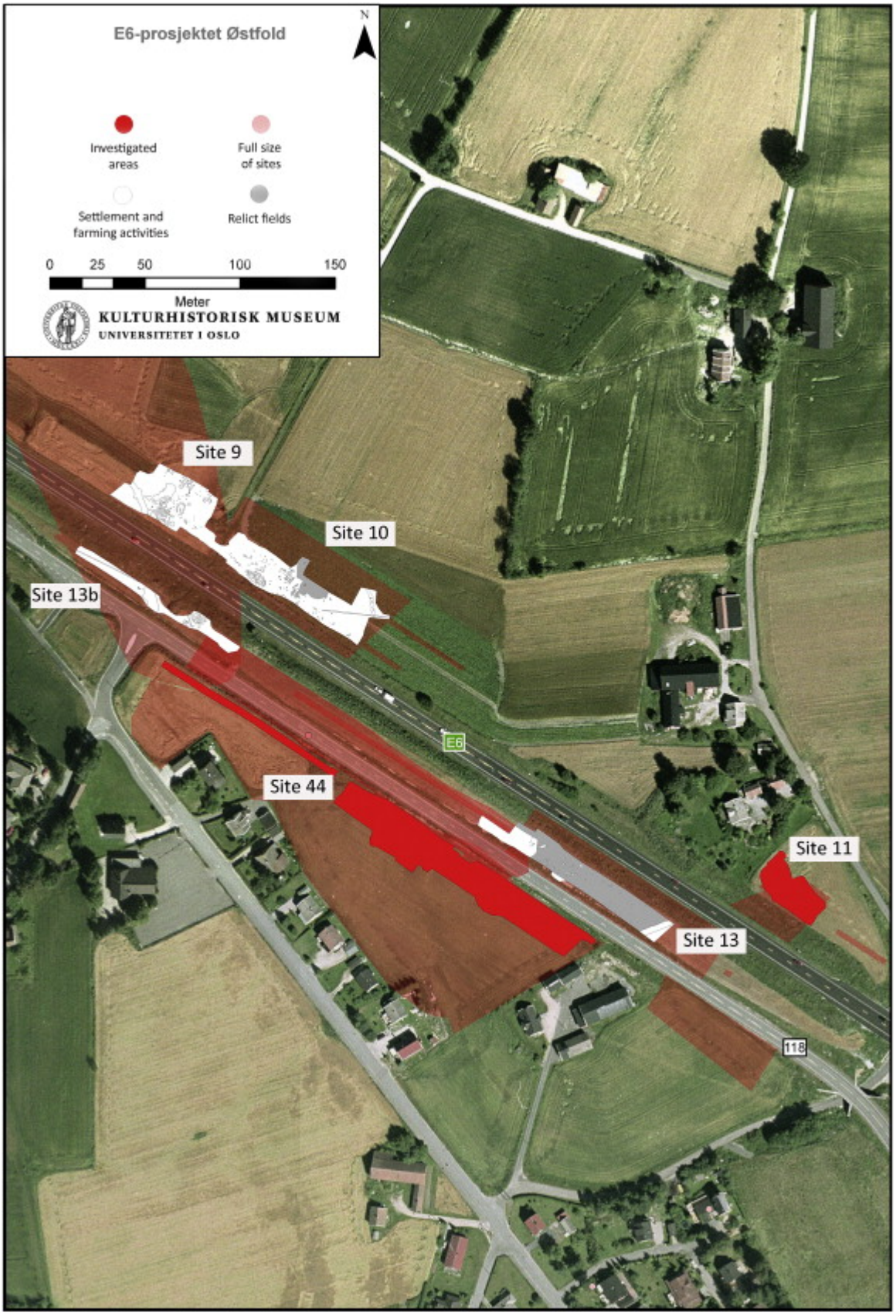

Fig. 5. The localization of site 9, 10, 11, 13 and 13b and 44, area 2. The number 118 refers to a local road. Orto photy by The Norwegian Public Road Administration.

Dated cereal grains demonstrated cultivation of grain in Østfold within the time-span from c. 2200 BC to 600 AD. The dates eliminate neither earlier nor later phases of cultivation. As the time-span for the sites investigated includes the Merovingian Period and Viking Age (c. 600–1000 AD), it is presumed that the cultivation of grains continued into these periods. Annual weeds were a part of the past field flora and the presence of these in settlement-context is most likely a result of those being harvested together with the cultivated plants.

Wild food plants occurred together and in combination with the cultivated plants which indicates that all these species were part of the human diet and that humans in the past had other strategies for supplies of plants food in their diet than for cultivation only.

In addition many other plants with less significance indicate specific ecological conditions in the past are present. Among these are the perennials clover (*Trifolium*), butter cup (*Ranunculus*), stinging nettle (*Urtica dioica)* and bedstraw (*Galium*) which might grow in environments influenced by anthropogenic processes while many sedges (*Carex*) grow on wet sites.

3.2. Case 2. Identification of agrarian activities in a relict field

The second case involved the combination of analysis of macrofossils, pollen and soil micro morphology in combination with ^{14}C-datings. Sediment samples were collected from cross-sections through relict fields, and in addition from contexts such as pits and fireplaces surrounding the fields.

The methods aimed at identifying the beginning and further development of agrarian activities in relict fields at the sites 6, 10 and 13 in area 2. In this paper the results achieved from the relict field at site 13 will serve as an example of the establishment and further development of a field, with minor supplement from the surrounding sites 9, 10, 11 and 44 (Fig. 5, cf. Fig. 1).

The fields at sites 10 and 13 are dated to the time-span between the Late Neolithic and the Roman Iron Age. Two different types of stratigraphy were recorded at these two fields. At site 13 the relict field was characterized by a distinct horizontal layer of sandy humus of up to 25 cm in thickness. Pockets of black sandy humus were found in the sandy sediment underneath. The relict field was covered by a layer of homogeneous sand 15–20 cm in thickness, which again was sealed by modern arable land (Fig. 6 and Fig. 7). The relict field covered an area of approximately 1000 m^2. The field type present at site 10 had no sand coating but was covered by modern arable land. The area of this field was c. 180 m^2. Distinct *ard* marks (a predecessor to the plough) in the transition zone between the bottom layer of the fields and the upper part of the underlying mineral soil were present at both fields (Fig. 8).

Fig. 6. A part of the sectioned relict field at site 13, area 2, showing the collection of seven out of eight samples for pollen analysis. Photo by Museum of Cultural History.

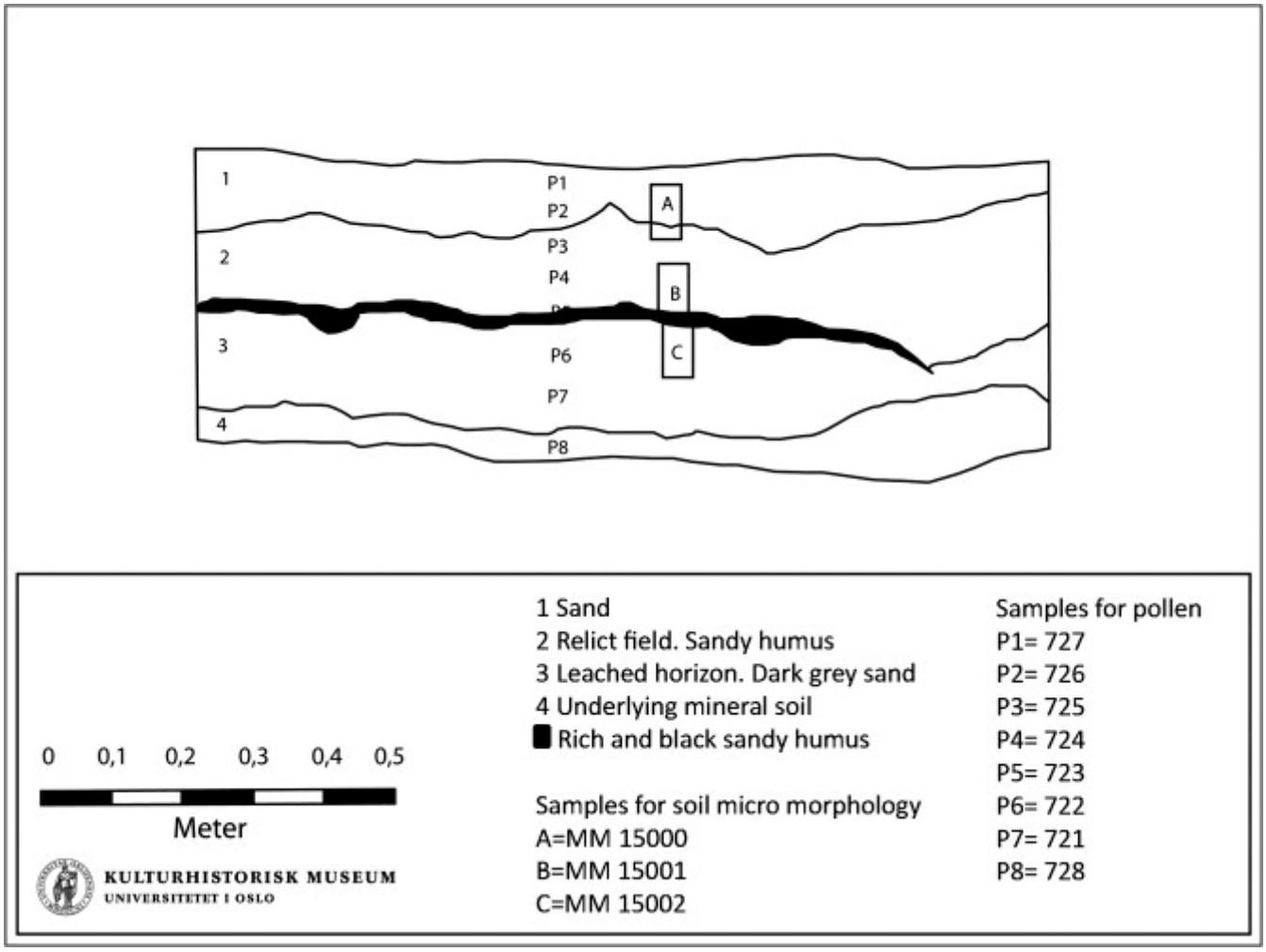

Fig. 7. Cross-section of the relict field at site 13, showing the collection of samples for the analysis of soil micro morphology.

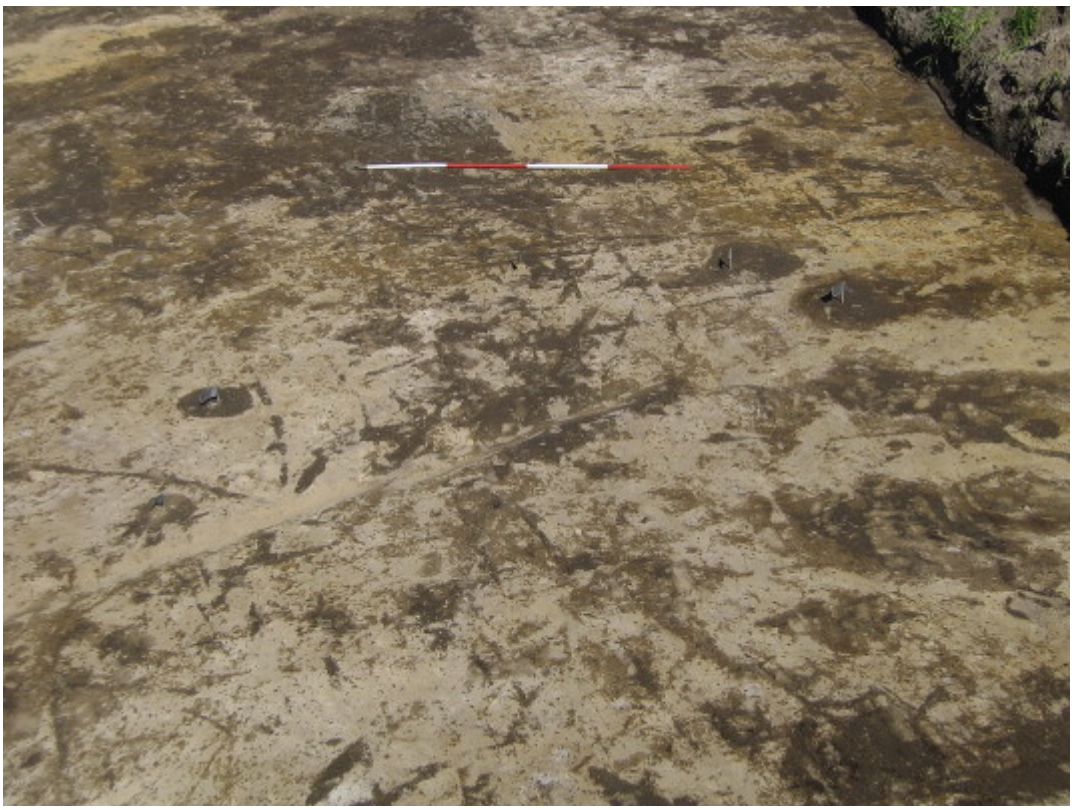

Fig. 8. *Ard* marks at site 13, area 2. Photo by Museum of Cultural History.

3.2.1. *Site 13–an example* of the establishment and further development of a relict field

The results achieved from the relict field at site 13 will serve as an example of past agricultural activities in a micro perspective. The macroscopic stratigraphy seen in the soil profile (Fig. 6) reveals clear horizontal boundaries between the field soil and the sandy sediments lying under and above while internal differences seen in the field soil are vague and seen only in soil micro morphology. The sand coating prevailed favourable conditions for the preservation of plant remains and it also protected the *ard* marks and other traces of agrarian activities. Charcoal from the field itself is dated to the transition between the Late Bronze Age and the Pre-Roman Iron Age. Charcoal and grains from two fireplaces and one posthole located on top of the sand layer are dated to the Roman Age, while charcoal from the sand layer is dated to the Migration Period (Table 4). The dates, in combination with the stratigraphy points at two separate phases; an early phase represented by the field and dated to the Late Bronze Age/Pre-Roman Iron Age c. 500 BC. A later phase represented by the fireplaces and posthole on top of the sand layer is dated to the Roman Age. Analysis of macrofossils, pollens and soil micro morphology resulted in a more detailed and comprehensive understandings of the field where the following phases and sequences were identified.

Table 4
Dates from the relict field at site 13, area 2.

Context	Sample ID	Material	^{14}C age (yr BP $\pm$ δ)	Calibrated age (yr BC/AD $\pm$ δ)
Relict field	TUa-5707	Charcoal	2465 $\pm$ 45	760–410 BC
Sand layer	TUa-5706	Charcoal	1515 $\pm$ 35	430–640 AD
Posthole	TUa-5620	Barley	1785 $\pm$ 45	180–335 AD
Fireplace	TUa-5708	Charcoal	1790 $\pm$ 40	180–325 AD
Fireplace	TUa-5666	Grain	1610 $\pm$ 35	415–535 AD

3.2.1.1. Phase 1

Phase 1 was represented by a sandy sediment with few visible traces of organic remains. In this phase no clear traces of human impact was identified neither in the macrofossils nor by analysis of soil micro morphology (Fig. 10, Table 2) while the analysis of pollen revealed a high content of microscopic charcoal fragments in the sediment (Fig. 9, samples 728, 721 and 722). The pollen analysis (cf. Fig. 9) showed forest of especially birch (Betula) and alder (Alnus) mixed with pine (Pinus), hazel (*C. avellana*) and deciduous forest represented by oak (Quercus), elm (Ulmus) and lime (Tilia). Grasses (Poaceae) dominated the herbaceous vegetation (Sageidet, 2007a:88–89). Analysis of soil micro morphology revealed scattered charcoal and a single piece of charred bone (Sageidet, 2007a: 63–65). It has not been possible to date the establishment of the field. Few macrofossils were found and no plant remains considered suitable as sample for ^{14}C-dating (Table 2). The stratigraphy in combination with radiocarbon dates from layers above (see phases 2 and 3) indicates that phase 1 at site 13 is older than 700 BC.

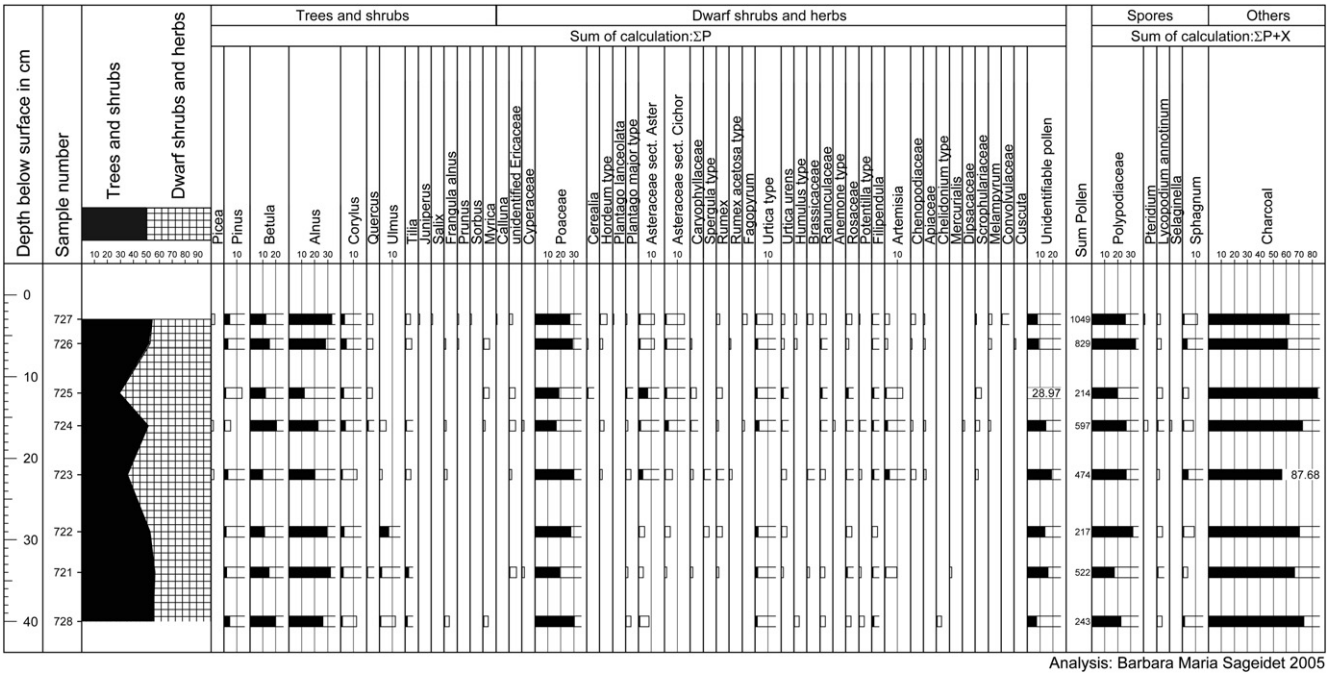

Fig. 9. Pollen diagram, site 13, area 2. Analysis: Barbara Maria Sageidet.

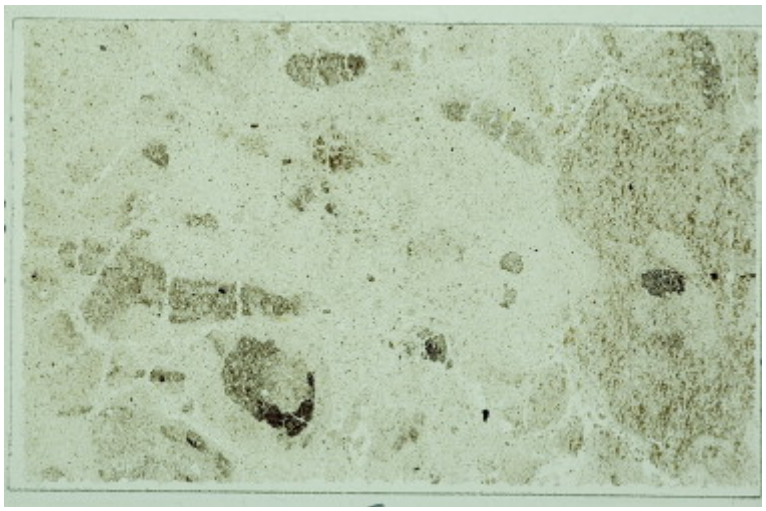

Fig. 10. Thin section MM 15000, from the relict field at site 13, area 2. Photo by Terje Tveit, Museum of Archaeology, University of Stavanger.

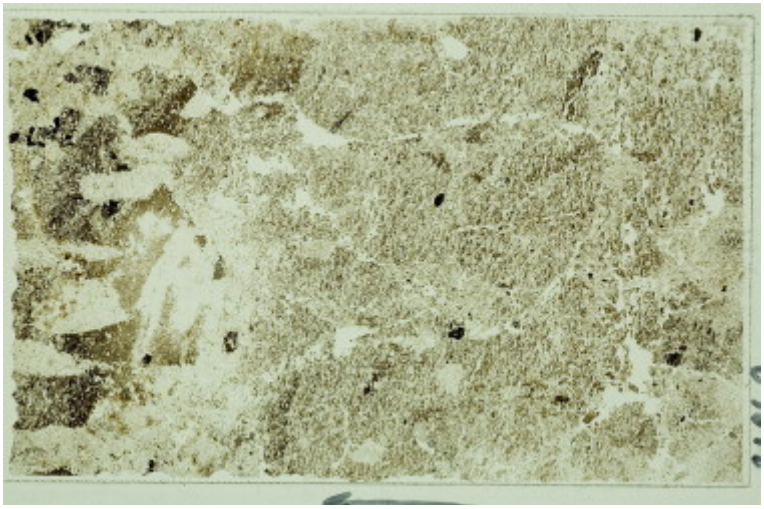

Fig. 11. Thin section MM 15001, from the relict field at site 13, area 2. Photo by Terje Tveit, Museum of Archaeology, University of Stavanger.

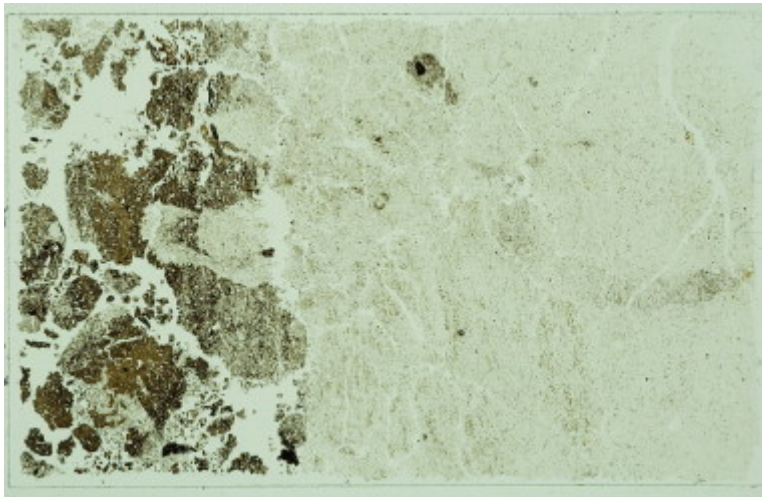

Fig. 12. Thin section MM 15002, from the relict field at site 13, area 2. Photo by Terje Tveit, Museum of Archaeology, University of Stavanger

3.2.1.2. Phase 2

Phase 2 was represented by a dark soil and is identified through a change in colour from grey sand with scattered inclusions of dark material in phase 1 to a dark soil (Fig. 6 and Fig. 7). Pollen of both barley *Hordeum*-type and unspecified grain Cerealia-type indicate cultivation at or close to the field while grazing is seen through pollen of greater plantain (Plantago major) and spores of Pteridium-type (cf. Fig. 9). It is also a rise in herb pollen types and the amount of microscopic fragments of charcoal in phase 2 compared to what is present in phase 1. The difference in soil micro morphology between the phases 1 and 2 is clear (Fig. 10). The lowest part of the organic sediments in phase 2 at site 13 has the same position in the stratigraphy as the lowest part of the organic sediments at site 10 from which a cereal grain is dated to late Neolithic time, 3610 ± 40 BP (Table 3). Grain of barley *Hordeum vulgare* from a pit at site 9, also in area 2, is also dated to late Neolithic time, 3660 ± 40 BP (Table 3). Together these dates indicate that the fields and settlement in area 2 might have originated in the Neolithic (Bårdseth, 2007b: 69–70).

3.2.1.3. Phase 3

Phase 3 was also represented by a dark sandy soil (Fig. 6 and Fig. 11). Plant macrofossils representing this phase were unidentified grains, and weeds such as fat hen (*C. album*) and sun of wart spurge (*E. helioscopia*). The pollen flora was represented by barley (*Hordeum*) which indicates cultivation of grain. A range of annual herbs were also recognized, among them buckwheat (Fagopyrum) which was grown for consumption but also may have occurred as a field weed, spurrey (Spergula-type), species from the families Asteraceae, pink or carnation (Caryophyllaceae) and pigweed (Chenopodiaceae), which are all common weeds in the field flora (Sageidet, 2007a: 88–89).

The soil micro morphologic analysis however revealed horizontal layers in the field soil interpreted as traces of repeated depositions of manure at the field and multiple plant remains characteristic for those stemming from dung. Also, the pattern of the sediment aggregates was distinguished from the dung. Due to these observations it is presumed that dung was present in the soil at this stage. The variations in the presence of dung imply spreading to the field in repeated episodes, but with various degrees of blending with the soil (Sageidet, 2007a: 65). Dung was spread on to the fields in order to improve its fertility and to raise the crops. Ard marks are occurring in the transition zone between the field soil and the underlying mineral soil at this site, and most likely an ard was also used to spread dung. The analysis also identified numerous diatoms and remains of insects. Both these types are common in wet and moist environments such as wells and dung heaps and might have been added to the field from human settlement. None of these specimens were identified to the level of species or genus.

3.2.1.4. Phase 4

The fourth and latest identified phase of the field is represented by a layer dominated by sand sealing the field at site 13 (Fig. 6, Fig. 7 and Fig. 12). The grain size is less than 0, 5 mm, which indicate that the sand might have been brought to the site by aeolian activity in the area close to the field. The sand layer had a homogenous character indicating deposition by one single episode – maybe a sandstorm? The regressive sea shore displacement in the region may have exposed great areas of old sea bottom covered with sand which could be spread by aeolian activity. Neither the macrofossils nor the pollen record and the soil micro morphological analysis proved any indications of human activity in the sand layer; thus it is sought to represents the end-of-use of the field.

3.2.2. Preliminary conclusions

The analysis of plant macrofossils, pollens and soil micro morphology has, alone and in combination, demonstrated activities and events that took place in the field at site 13 and surrounding areas; Grazing, the cultivation of barley (*Hordeum*) and flax (*L. usitatissimum*) identified in the pollen record from site 11 indicates that also flax could have been cultivated in this area. Fertilizing and ploughing have improved the soil and soil-fertility as well as the quality and quantity of the crops. The analysis demonstrated a development-sequence, starting with a natural environment and resulting in a cultural landscape. The time frame for these activities are from the Late Neolithic to the Migration Period.

Agrarian activities at the site, such as grazing, fertilizing and the identification of cultivated plants, were neither visible for the human eye nor evident through traditional archaeological survey methods. Palaeobotanical analysis in combination with sediment analysis have complemented each other in an appropriate way and showed decisive for the results achieved.

4. Conclusions

The main objective of this paper is to present and discuss results achieved by an interdisciplinary approach and illustrate how they supply and expand former knowledge about past settlement in SE Norway. In particular the results have contributed to illustrate a theme that to a lesser degree has been explored till now – past settlement and agricultural practice. Distinct results from the two cases presented in the paper can be summarized as follows: A broad analysis of plant macrofossils, geographical as well as chronological, contributed to draw a general map of the use of cultivated plants and wild food plants all over Østfold, from the Neolithic to the Viking Age (c. 2200 BC–1000 AD). A combination of macrofossils, pollen and soil micro morphological analysis contributed to map the transition of an area, from a natural environment, via grassland into a cultivated field. The introduction of cultivated plants is seen both in the analysis of macrofossils and pollen, but both these methods have some limitations. Hulled barley (H. vulgare var vulgare) and naked barley (H. vulgare var nudum) identified by macrofossil analysis to the level of subspecies both belong to the pollen type barley (Hordeum). Pollen of millet (P. miliaceum) is according to Beug (2004) almost impossible to distinguish from the pollen type wheat (Triticum-type). While macrofossils of trees mainly have been found as fragments of charcoal, pollen analysis have revealed forest vegetation with many types of trees and bushes. The soil micro morphological analysis revealed the anthropogenic influence on the soil and specific events such as the use of dung as a fertilizing element in fields.

The investigated sites are geographically distributed along the moraine and thus close to good communication routes between the interior lakes, rivers and the coast. The broadly distributed sites were also in the past linked to favourable communication routes which implies that the results gained from the *E6-project* are representing a cross-section of the county and thus valid for greater parts of Østfold and also for surrounding regions.

Isolated and together, these results have contributed to a new understanding of the past in Østfold. They represent a new set of data which gives us a more concise picture of pre-historic settlement and farming activities. The investigations of these topics have hitherto been limited for this region. The combination of the interdisciplinary approach and the mechanical stripping of topsoil showed decisive for the results.

The interdisciplinary approach has resulted in new fresh understanding of pre-historic times in Østfold and neighbouring regions, which will serve as an important reference for future investigations, but also for reinterpreting former studies.

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